

Exam 1. 100 pts. Answer Questions 1- 30 on Scantron. 3 pts each. Answer remaining questions on the exam. (NOTE: Ques. 23, 25, 26 are incomplete in pdf file.)

1. At standard conditions one molar mass of any gas will occupy 22.4 L. Therefore
  - (A) the molecular mass of any gas is the same.
  - (B) the molecules of all gases have the same velocity at standard conditions.
  - (C) all gases are diatomic.
  - (D) there will be the same number of molecules in one molar mass of any gas.
  - (E) the molecules of all gases are in rapid motion.
  
2. A one-liter container is filled with one mole of hydrogen at 25 °C. A second one liter container is filled with one mole of oxygen at 25 °C. Comparing the pressure of the hydrogen to the oxygen, the ratio will be
  - (A) 1:1    (B) 2:1    (C) 1:16    (D) 1:8
  
3. When the absolute temperature of a fixed quantity of an ideal gas is quadrupled and the pressure is doubled, what is the net effect on the volume of the gas?
  - (A) The volume remains constant.
  - (B) The volume increases two-fold.
  - (C) The volume increases four-fold.
  - (D) The volume increases eight-fold.
  
4. At constant volume, the pressure of gas **Y** increases with increasing temperature because as the temperature increases,
  - (A) molecules of **Y** move faster.
  - (B) the molecular volume of **Y** increases.
  - (C) the mass of **Y** molecules increases.
  - (D) molecular collisions are more elastic.
  - (E) molecules are closer together.

5. A student collected 40 mL of  $\text{H}_2$  gas when the temperature was  $20^\circ\text{C}$  and the pressure was 720 mmHg. The next day the temperature was  $20^\circ\text{C}$ , but he had only 38.4 mL of gas. The new pressure is

- (A) 691 mmHg (D) 750 mmHg  
(B) 700 mmHg (E) 760 mmHg  
(C) 721 mmHg

6. When 18.0 g of water is heated to steam at  $100^\circ\text{C}$ , the volume at 1 atm pressure is approximately

Molar Mass	
$\text{H}_2\text{O}$	$18.0 \text{ g}\cdot\text{mol}^{-1}$

- (A)  $18.0 \times \frac{273}{373} \text{ mL}$   
(B)  $18.0 \times \frac{373}{273} \times 760 \text{ mL}$   
(C)  $18.0 \times 100 \text{ mL}$   
(D)  $22.4 \times \frac{373}{760} \text{ L}$   
(E)  $22.4 \times \frac{373}{273} \text{ L}$
7. Real gases are most like ideal gases at
- (A) high pressure and high temperature.  
(B) low pressure and low temperature.  
(C) high pressure and low temperature.  
(D) low pressure and high temperature.
8. The mass of  $560 \text{ cm}^3$  (STP) of an unknown gas is 1.60 g. This gas could be

Molar Masses	
$\text{CO}_2$	$44. \text{ g}\cdot\text{mol}^{-1}$
$\text{Cl}_2$	$71. \text{ g}\cdot\text{mol}^{-1}$
$\text{O}_2$	$32. \text{ g}\cdot\text{mol}^{-1}$
$\text{SO}_2$	$64. \text{ g}\cdot\text{mol}^{-1}$

- (A) oxygen. (C) chlorine.  
(B) carbon dioxide. (D) sulfur dioxide.

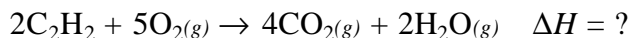
9. When equal masses of methane gas and oxygen are added to an empty container at 25 °C, the fraction of the pressure exerted by the oxygen is

Molar Masses	
CH <sub>4</sub>	16. g·mol <sup>-1</sup>
O <sub>2</sub>	32. g·mol <sup>-1</sup>

- (A)  $\frac{1}{3}$  total pressure.
- (B)  $\frac{1}{2}$  total pressure.
- (C)  $\frac{2}{3}$  total pressure.
- (D)  $\frac{1}{3}$  total pressure  $\times \frac{273}{298}$
- (E)  $\frac{2}{3}$  total pressure  $\times \frac{273}{298}$
10. At the same temperature and pressure, CH<sub>4</sub> effuses

Molar Masses	
CH <sub>4</sub>	16. g·mol <sup>-1</sup>
SO <sub>2</sub>	64. g·mol <sup>-1</sup>

- (A) one-half as fast as O<sub>2</sub>
- (B) two times as fast as O<sub>2</sub>
- (C) at the same rate as O<sub>2</sub>
- (D) one-fourth as fast as O<sub>2</sub>
11. The heats of formation,  $\Delta H_f^\circ$  in are shown in the table. What is  $\Delta H$  in kJ for the reaction



Compound	$\Delta H_f^\circ$
C <sub>2</sub> H <sub>2(g)</sub>	+227
H <sub>2</sub> O <sub>(g)</sub>	-242
CO <sub>2(g)</sub>	-393

- (A)  $-4 \times 94.0 - 2 \times 57.8 + 54.2$
- (B)  $-4 \times 94.0 - 2 \times 57.8 - 54.2$
- (C)  $-4 \times 94.0 - 2 \times 57.8 - 2 \times 54.2$
- (D)  $-4 \times 94.0 - 2 \times 57.8 + 2 \times 54.2$

12. When 45.0 g of an alloy at 100.0 °C is dropped into 100.0 g of water at 25.0 °C, the final temperature is 37.0 °C. What is the specific heat of the alloy?

Data for Water	
specific heat <sub>(water)</sub>	4.184 J·g <sup>-1</sup> ·°C <sup>-1</sup>

- (A) 0.423 J·g<sup>-1</sup>·°C<sup>-1</sup> (C) 9.88 J·g<sup>-1</sup>·°C<sup>-1</sup>  
(B) 1.77 J·g<sup>-1</sup>·°C<sup>-1</sup> (D) 48.8 J·g<sup>-1</sup>·°C<sup>-1</sup>
13. The most stable ion of sodium is isoelectronic with the
- (A) magnesium atom.  
(B) most stable ion of fluorine.  
(C) argon atom.  
(D) sodium atom.
14. Which ion has the largest radius?
- (A) Te<sup>2-</sup> (B) F<sup>-</sup> (C) Rb<sup>+</sup> (D) Mg<sup>2+</sup>
15. Which element has the *smallest* atomic radius?
- (A) fluorine (B) chlorine (C) bromine (D) iodine  
(E) astatine
16. Among the alkali metals, cesium reacts more rapidly than sodium. To what may this be ascribed?
- (A) Cesium has a higher nuclear charge.  
(B) The valence electron in cesium is at a greater average distance from the nucleus.  
(C) Cesium has a higher atomic weight.  
(D) Cesium has more electrons.  
(E) Cesium has more neutrons.
17. Which would be expected to be the most electronegative?
- (A) P (B) As (C) Si (D) Al

18. Element **X** has these ionization energies:

Ionization Energy	
First	419 kJ/mol
Second	3051 kJ/mol
Third	4411 kJ/mol

Element **X** most likely is D

- (A) Ca (B) Si (C) Br (D) K

19. Based on their positions in the periodic table, which is most likely to replace selenium, Se, in a biological system?

- (A) Te (B) Br (C) As (D) I

20. The electron distributions for five elements by principal quantum number are

(1) 2, 8, 2	(4) 2, 8, 18, 7
(2) 2, 8, 8	(5) 2, 8, 18, 8
(3) 2, 8, 14, 2	

The elements most likely to be closely related in chemical properties are:

- (A) (1) and (2) (D) (1) and (3)  
 (B) (2) and (3) (E) (2) and (5)  
 (C) (4) and (5)

21. Which is most likely to be formed by electron transfer and be ionic?

	Main Groups							
	I	II	III	IV	V	VI	VII	(O)
First Period								
Second Period	<b>X</b>	<b>Y</b>	<b>Z</b>	<b>P</b>		<b>Q</b>	<b>S</b>	<b>U</b>
Third Period	<b>W</b>					<b>R</b>	<b>T</b>	<b>M</b>

- (A) a compound of **U** and **S**  
 (B) a compound of **P** and **S**  
 (C) a compound of **Z** and **P**  
 (D) a compound of **Y** and **T**  
 (E) a compound of **Q** and **T**

22. Which atom description represents an element that could form a covalent compound with an atom of a nonmetal?

(A) 

Nucleus	$n = 1$	$n = 2$	$n = 3$	$n = 4$
$3p, 4n$	$2e^-$			

(B) 

Nucleus	$n = 1$	$n = 2$	$n = 3$	$n = 4$
$11p, 12n$	$2e^-$	$8e^-$	$1e^-$	

(C) 

Nucleus	$n = 1$	$n = 2$	$n = 3$	$n = 4$
$29p, 35n$	$2e^-$	$8e^-$	$18e^-$	$1e^-$

(D) 

Nucleus	$n = 1$	$n = 2$	$n = 3$	$n = 4$
$8p, 10n$	$2e^-$	$6e^-$		

23. Which compound contains the **longest** carbon-to-nitrogen bond?

24. How many electrons should be shown in the Lewis dot structure for carbon monoxide?

- |           |                  |
|-----------|------------------|
| (A) eight | (C) fourteen     |
| (B) ten   | (D) twenty-eight |

25. Which has an **incorrect** arrangement of electrons or charge?

26. The most reasonable Lewis structure for HOCl is

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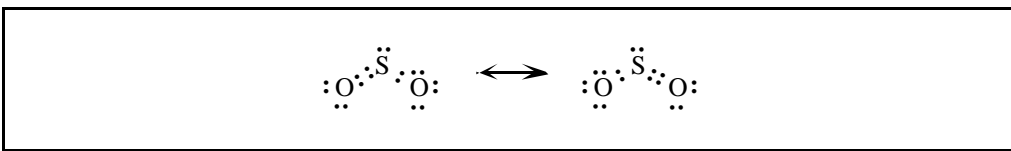
27. Which pair is geometrically similar?

- (A)  $\text{SO}_2$  and  $\text{CO}_2$       (C)  $\text{CO}_2$  and  $\text{OF}_2$   
(B)  $\text{PH}_3$  and  $\text{BF}_3$       (D)  $\text{SO}_2$  and  $\text{O}_3$

28. An  $sp$  hybridized central atom can be used to describe the bonding in

- (A)  $\text{CH}_4$     (B)  $\text{HCN}$     (C)  $\text{H}_2\text{C}=\text{O}$       (D)  $\text{OF}_2$

29. Sulfur dioxide can be described by two resonance structures:



This implies that

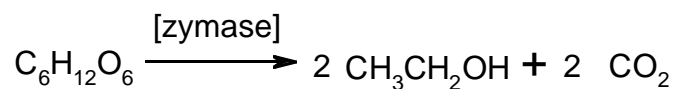
- (A) the two bonds in  $\text{SO}_2$  are of equal length, and the electronic distribution in the two SO bonds is identical.  
(B) the single bond is longer than the double bond and the electronic distribution in the two SO bonds is different.  
(C) an electron pair in the  $\text{SO}_2$  molecule alternates back and forth between the two sulfur–oxygen electron pairs so that the two different bonds seem to exchange positions.  
(D) the  $\text{SO}_2$  molecule revolves so that the two different bonds seem to exchange positions.

30. Which compound would be expected to have the largest dipole moment, that is, the most polar?

- (A)  $\text{CO}_2$  (linear)      (C)  $\text{BF}_3$  (trigonal planar)  
(B)  $\text{SO}_2$  (bent)      (D)  $\text{CF}_4$  (tetrahedral)

**Problems continue on the following page.**

31. (6pts.) Glucose ferments according to the following equation;  $\Delta H_{\text{rxn}} = -67 \text{ kJ}$  for 88 g of  $\text{CO}_2$  produced.

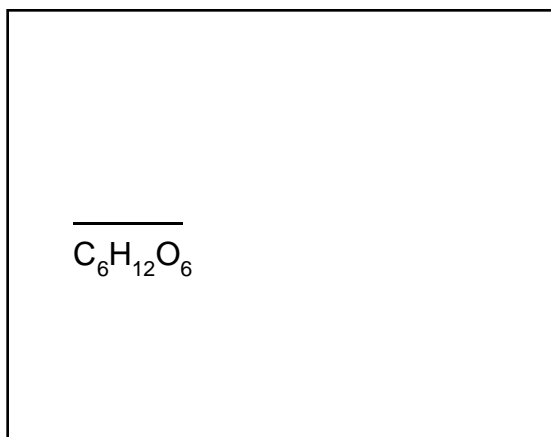


Atomic Molar Masses	
C	12.0 g·mol <sup>-1</sup>
H	1.0 g·mol <sup>-1</sup>
O	16.0 g·mol <sup>-1</sup>

Calculate the energy for the reaction of 90.0 g of glucose. Show your calculation.

- b) Sketch the reaction in the following box. Clearly indicate if the reaction is endothermic or exothermic and show the quantity of energy that you calculated in (a).

$\Delta E$





32. (4pts) How does the density of phosgene gas,  $\text{COCl}_2$ , compare with the density of hydrogen sulfide gas,  $\text{H}_2\text{S}$ , at the same temperature and pressure? Select an answer and provide a brief explanation or mathematical equation to support your selection.

Atomic Molar Masses	
C	12.0 $\text{g}\cdot\text{mol}^{-1}$
Cl	35.5 $\text{g}\cdot\text{mol}^{-1}$
H	1.0 $\text{g}\cdot\text{mol}^{-1}$
O	16.0 $\text{g}\cdot\text{mol}^{-1}$
S	32.0 $\text{g}\cdot\text{mol}^{-1}$

- (A) approximately the same      (D) approximately 5 times as great  
(B) approximately twice as great      (E) approximately 7 times as great  
(C) approximately 3 times as great